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Patent
Attorney's Docket No. 015290-506

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of	
Ting CHIEN et al.	Group Art Unit: 1765
Application No.: 09/820,692	Examiner: K.C. Chen
Filed: March 30, 2001	Appeal No. Not Yet Assigned
For: PLASMA ETCHING OF DIELECTRIC LAYER WITH SELECTIVITY TO STOP LAYER	

BRIEF FOR APPELLANTS

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

This Appeal is from the decision of the Primary Examiner dated August 7, 2002 (Paper No. 11), finally rejecting Claims 1-25, which are reproduced as an Appendix to this brief.

The Commissioner is hereby authorized to charge [X] $320.00 (120) Government fee to Deposit Account No. 02-4800, as well as any other appropriate fees under 37 C.F.R. §§1.16, 1.17, and 1.21 that may be required by this paper, and to credit any overpayment, to Deposit Account No. 02-4800. This paper is submitted in triplicate.

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I. Real Party in Interest

The present application is assigned to Lam Research Corporation, by way of an Assignment filed in the U.S. Patent and Trademark Office on June 8, 2001 and recorded at Reel 011873, Frame 0705.

II. Related Appeals and Interferences

Appellants' legal representative, or the Assignee, does not know of any other Appeal or of any Interference, which will affect, be directly affected by, or have bearing on, the Board's decision in the pending Appeal.

III. Status of Claims

Claims 1-25 are pending. Claims 1-25 stand finally rejected and are on Appeal. A clean version of claims 1-25 is set forth in the attached Appendix. Claim 1 is the only independent claim. Claims 2-25 depend directly or indirectly from Claim 1.

IV. Status of Amendments

A Request for Reconsideration ("Request") was filed on September 9, 2002. In response, an Advisory Action was mailed September 27, 2002. The Advisory Action stated that the Request overcame the rejection under 35 USC §112, paragraph 1.

V. Summary of the Invention

The invention provides a process for plasma etching a silicon nitride layer with selectivity to an overlying and/or underlying oxide layer, comprising the steps of introducing the semiconductor substrate into a plasma etching chamber, supplying etching gas to the chamber and energizing the etching gas into a plasma state, and etching openings in the oxide layer with a high selectivity of oxide to nitride. The etching gas is hydrogen free and includes a fluorocarbon reactant, an oxygen reactant and an optional inert carrier gas, the fluorine:carbon ratio of the fluorocarbon gas being 1.5 or less.

According to one aspect of the invention, the underlying and/or overlying oxide layer comprises a doped or undoped silicon dioxide, BPSG, PSG, TEOS, thermal silicon oxide or low-k material such as SiLK. The openings can comprise grooves corresponding to a conductor pattern, via openings or contact openings. The openings can be etched in the underlying and/or overlying oxide layers so as to have an aspect ratio of at least 3:1. The silicon nitride etching gas can include a hydrogen-free fluorocarbon reactant represented by C_xF_y wherein y/x is 1.5 or less. For example, the fluorocarbon reactant can be selected from the group of CF, C_2F_2, C_2F_3, C_3F_4, C_3F_6, C_4F_4, C_4F_6, C_6F_6, and C_6F_8. The semiconductor substrate can include an electrically conductive or semiconductive layer such as a metal-containing layer selected from the group consisting of Al, Al alloys, Cu, Cu alloys, Ti, Ti alloys, doped or undoped polycrystalline or single crystal silicon, TiN, TiW, Mo, silicides of Ti, W, Co and/or Mo or alloys thereof, etc. The optional carrier gas can be selected from the group consisting of Ar, He, Ne, Kr, Xe or mixtures thereof.

In a single wafer plasma etch chamber for processing 200 mm wafers, the oxygen reactant can be supplied as O_2 or as an oxygen-containing gas such as CO to the plasma reactor at a flow rate of 15 to 100 sccm, the fluorocarbon reactant can be supplied to the plasma reactor at a flow rate of 15 to 100 sccm, and the optional carrier gas can be supplied to the plasma reactor at a flow rate of 10 to 500 sccm. As an example, oxygen, CH_3F, and Ar can be supplied to the plasma reactor at flow rates of 15 to 60 sccm, 15 to 60 sccm and 0 to 500 sccm, respectively. During the etching step, the plasma reactor is preferably maintained at a vacuum pressure of 5 to 500 mTorr, preferably 150 to 250 mTorr in the case of a medium density plasma reactor. The etching step can be followed by additional etching steps and subsequent filling of the openings with metal. The method of the invention can also include steps of forming a photoresist layer on the substrate, patterning the photoresist layer to form a plurality of openings followed by etching a metallization pattern of conductor lines, via or contact openings in the overlying oxide layer.

VI. The Issues

The issues on Appeal are:

1. Whether Claims 24 and 25 are unpatentable under 35 U.S.C. § 112, first paragraph;
2. Whether Claims 1-5, 9-12 and 14-25 are unpatentable under 35 U.S.C. § 103(a) over U.S. Patent No. 6,174,451 ("Hung") in view of U.S. Patent No. 6,074,959 ("Wang");
3. Whether Claims 6-8 and 13 are unpatentable under 35 U.S.C. § 103(a) over Hung in view of Wang and U.S. patent No. 6, 228,438 ("Schmitt").

VII. Grouping of Claims

The claims on Appeal do not stand or fall together. For convenience in handling this Appeal, the claims will be grouped and argued as follows:

Group I: Claims 24 and 25.

Group II: Claims 1-5, 9-12 and 14-25.

Group III: Claims 6-8 and 13.

Pursuant to 37 C.F.R. § 1.192(c)(7), in this Appeal, the claims of Groups II and III, respectively, do not stand or fall with the claims of Group I. Reasons for the separate patentability of the claims of Groups I, II and III are set forth below.

VIII. The Cited References

Hung discloses an oxide etching process wherein a hydrogen-containing etch gas is used for selectively etching oxide over a feature having a non-oxide composition such as silicon nitride (Abstract). Hung discloses an oxide etching process for selectively etching oxide over a feature having a non-oxide composition in a high-density plasma reactor using unsaturated fluorocarbons with a low but *finite hydrogen content* (Abstract, Column 5, lines 47-56 and Column 11, lines 1-10). Specifically, Hung uses a two-step oxide etch in order to obtain the desired selectivity to an underlying nitride layer (Column 8, lines 26-34).

Hung also teaches away from including oxygen in the main etch or in the over etch.

Wang discloses a plasma etch process applicable to a self-aligned contact etch requiring high selectivity to nitride or other non-oxide materials (Abstract). $C_3H_2F_6$ is the principal etching gas in the presence of a substantial amount of an inactive gas such as argon (Abstract). Other gases such as C_3HF_7 and $C_3H_3F_5$ can be also be used and CH_2F_2 may be combined with the etching gas (Abstract).

Schmitt discloses a plasma reactor for treating large sized substrates between electrodes 3,5 wherein a solid or gaseous dielectric layer 11 having a non-planar shaped surface-profile is used to compensate for non-uniformity in the reactor or generating a given distribution profile (Abstract).

IX. <u>Argument I</u>

A. <u>The Legal requirements for a §112, first paragraph rejection</u>

In <u>In re Bowen</u>, 181 U.S.P.Q. 48, 51 (C.C.P.A. 1974), the court explained that:

> "[I]t is incumbent upon the Patent Office, whenever a rejection on [the] basis [of nonenablement] is made, to explain <u>why</u> it doubts the truth or accuracy of any statement in a supporting disclosure and to back up assertions of it own with acceptable evidence or reasoning which is inconsistent with the contested statement." (Emphasis in original.)

B. <u>Examiner's Rationale for the Rejection</u>

In the Advisory Action, the rejection of Claim 23 (which is directed to a "hydrogen-free" etchant gas) was withdrawn. Accordingly, the Examiner agrees that there is support in the application for an etchant gas that does not contain hydrogen. The Examiner contends, however, that there is no support for the claimed "hydrogen-free fluorocarbon gas" in Claims 24 and 25.

C. <u>Reasons Supporting Reversal of Rejection</u>

Claims 24 and 25 stand rejected under 35 U.S.C. § 112, first paragraph, for allegedly containing subject matter not described in the specification. Claim 24 is directed to an etchant gas consisting essentially of a *hydrogen-free fluorocarbon gas*, an oxygen-

containing gas and a optional carrier gas. Claim 25 is directed to an etchant gas consisting of a *hydrogen-free fluorocarbon gas*, an oxygen-containing gas and a optional carrier gas.

In the Advisory Action, the Examiner stated that there is no support for "consists essentially of" in Claim 24 or "consists of" in Claim 25. However, such terminology relates to "transitional phrases" used to define the scope of a claim. See MPEP §2111.03 "Transitional Phrases." Given the explanation of the definition of such phrases in the MPEP, it is submitted that there is no need for such terms to be discussed in the specification.

Support for the claimed hydrogen-free etch gas can be found in the specification as follows:

> Especially good selectivity of oxide to nitride can be obtained when the etch gas is free of hydrogen and/or nitrogen. (Emphasis added, page 17, lines 19-20.)
>
> The fluorocarbon is preferably hydrogen-free and may comprise at least one C_xF_y gas... (Emphasis added, page 18, lines 20-21.)
>
> According to the invention, oxygen is added in an amount effective to control the etch rate selectivity of the etching gas chemistry. That is, the oxygen is effective to prevent etch stop by reacting with polymer at the bottom of the etched openings. The advantageous effects of the invention can be achieved by supplying the oxygen reactant and fluorocarbon reactant to plasma etching reactor at a flow rate ratio of oxygen reactant to fluorocarbon reactant of 1.5 or less. For selective etching of BPSG in a medium density plasma etch reactor, the flow rate ratio of oxygen reactant to fluorocarbon reactant is preferably 0.5 to 1.2...[t]he etching gas mixture may optionally include other gases and/or an inert carrier gas such as argon (Ar), helium (He), neon (Ne), krypton (Kr), xenon (Xe) and mixtures thereof. (Emphasis added, page 18, line 12 through page 19, line 3.)

From the foregoing excerpts from the specification, Applicants respectfully submit that the subject matter of Claims 24 and 25 does not introduce any new matter. The

specification clearly discloses a hydrogen-free etch gas and a hydrogen-free fluorocarbon gas such as C_xF_y. Thus, this rejection should be reversed.

X. Argument II

A. The Legal Requirements for A Rejection Under 35 USC §103(a)

The Supreme Court in Graham v. John Deere, 383 U.S. 1, 18, 148 USPQ 459, 467 (1966), set forth the basic test for patentability under 35 U.S.C. § 103:

> Under § 103, the scope and content of the prior art are to be determined; differences between the prior art and the claims at issue are to be ascertained; and the level of ordinary skill in the pertinent art resolved. Against this background, the obviousness or nonobviousness of the subject matter is determined. Such secondary considerations as commercial success, long felt but unsolved need, failure of others, etc., might be utilized to give light to the circumstances surrounding the origin of the subject matter to be patented.

In In re Ehrreich and Avery, 200 USPQ 504, 509-510 (CCPA 1979), the Court of Customs and Patent Appeals further clarified the basic test set forth in Graham v. John Deere:

> We must not here consider a reference in a vacuum, but against the background of the other references of record which may disprove theories and speculations in the reference or reveal previously undiscovered or unappreciated problems. The question in a § 103 case is what the references would collectively suggest to one of ordinary skill in the art. In re Simon, 461 F.2d 1387,174 USPQ 114 (CCPA 1972). It is only by proceeding in this manner that we may fairly determine the scope and content of the prior art according to the mandate of Graham v. Deere Company, 383 US 1, 17, 148 USPQ 459, 467 (1966) (emphasis in original).

Regarding the scope and content of the prior art inquiry of Graham v. Deere Company, any reference that is relied upon in a rejection under 35 U.S.C. § 103 must qualify as "analogous art". According to the Federal Circuit in In re Clay, 23 USPQ2d 1058, 1060-61 (Fed. Cir. 1992), in order for a reference to qualify as analogous art, it must

be established that (1) the reference is from the same field of endeavor, regardless of the problem addressed by the invention, and (2) if the reference is not within the same field of endeavor, then the reference must be reasonably pertinent to the particular problem with which the invention is involved. As stated in In re Wood and Eversole, 202 USPQ 171, 174 (CCPA 1979), "[t]he rationale behind this rule precluding rejections based on combination of teachings of references from nonanalogous arts is the realization that an inventor could not possibly be aware of every teaching in every art."

According to M.P.E.P. § 2143, to establish a *prima facie* case of obviousness, (1) "there must be some suggestion or motivation, either in references themselves or in the knowledge generally available to one of ordinary skill in the art, to ... combine reference teachings"; (2) "there must be a reasonable expectation of success"; and (3) "the prior art ... references when combined ... must teach or suggest all the claim limitations". The Patent Office has the initial burden of establishing each of these requirements of a *prima facie* case of obviousness. In re Piasecki, 223 USPQ 785, 787 (Fed. Cir. 1984) and In re Warner, 154 USPQ 173 (CCPA 1967).

The combined teachings of references must provide some teaching, suggestion or incentive to support the asserted combination in order to establish a *prima facie* case of obviousness. In re Geiger, 2 USPQ2d 1276 (Fed. Cir. 1987). The motivation to modify a teaching must come from the prior art and not from Applicants' disclosure, as it is improper merely to use inventors' teachings against them in determining whether prior art references would have suggested the claimed invention to a person having ordinary skill in the art. W.L. Gore v. Garlock, Inc., 220 USPQ 303, 312-13 (Fed. Cir. 1983). Furthermore, "[t]he mere fact that the prior art could be so modified would not have made the modification obvious unless the prior art suggested the desirability of the modification". In re Gordon, 221 USPQ 1125, 1127 (Fed. Cir. 1984).

The proposed modification also must have had a reasonable expectation of success to one having ordinary skill in the art at the time the invention was made. Amgen, Inc. v. Chugai Pharm. Co., 18 USPQ2d 1016, 1023 (Fed. Cir. 1991). The reasonable expectation

of success must also have come from the prior art and not Applicants' disclosure. In re Vaeck, 20 USPQ2d 1438, 1442 (Fed. Cir. 1991). Whether it would have been "obvious to try" or obvious to experiment by one having ordinary skill in the art is an improper basis for determining obviousness. In re Dow Chemical Co. v. American Cyanamid Co., 5 USPQ2d 1529, 1532 (Fed. Cir. 1988).

B. Examiner's Rationale For the Rejection

Claims 1-5, 9-12 and 14-25 stand rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over U.S. Patent No. 6,174,451 to Hung et al. ("Hung") in view of U.S. Patent No. 6,074,959 to Wang et al. ("Wang"). The reasons for this rejection are set forth in numbered paragraph 4, on pages 2-6 of the Official Action. In particular, the Official Action alleges that (1) Wang discloses the use of an oxygen-containing gas with a fluorocarbon main etchant gas to etch an oxide (dielectric) layer and (2) it would have been obvious to modify the C_4F_6-based oxide etch of Hung to include the oxygen-containing gases of Wang. This rejection should be reversed for the following reasons.

C. Claimed Subject Matter

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising (a) supporting a semiconductor substrate in a plasma etch reactor, the substrate including a dielectric layer over a stop layer; (b) supplying an etchant gas to the plasma etch chamber; and (c) etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas. As set forth below, the combination of Hung and Wang fails to teach or reasonably suggest all of the claim limitations. Further, persons of ordinary skill in the art would not have had the requisite reasonable expectation of success when combining the references in the manner suggested in the Official Action.

D. Hung Teaches Away From Using Oxygen

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising . . . (c) etching openings in the dielectric layer by

energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas.

Hung discloses an oxide etching process for selectively etching oxide over a feature having a non-oxide composition in a high-density plasma reactor using unsaturated fluorocarbons with a low but *finite hydrogen content* (see abstract, Column 5, lines 47-56 and Column 11, lines 1-10). Specifically, Hung uses a two-step oxide etch in order to obtain the desired selectivity to an underlying nitride layer (See Column 8, lines 26-34).

As disclosed by Hung, without the polymerizing CH_2F_2 (used in the over etch recipe) significant nitride corner faceting is observed (See column 10, lines 29-34). Thus, the over etch recipe of Hung is intended to circumvent the poor nitride selectivity of the main etch recipe (See column 10, lines 32-34).

In contrast to the claimed method, Hung does not disclose or suggest a method of etching a dielectric layer with selectivity to an underlying stop layer wherein the etchant gas comprises an *oxygen-containing* gas. Hung uses "a more heavily polymerizing fluorocarbon gas" in the over etch gas in order to obtain nitride selectivity (See column 8, lines 13-16). Hung's over etch to obtain "a complete etch without producing excessive nitride faceting" uses an etchant gas which is an oxygen-free gas. While Hung discloses use of oxygen gas to remove the nitride layer (column 10, lines 47-50), Hung specifically states that the *"oxygen destroys any nitride selectivity"* (Emphasis added, see column 10, line 51). Thus, Hung *teaches away* from using an oxygen-containing gas to etch a dielectric layer with selectivity to an underlying nitride layer.

E. Wang's Oxygen Gas is Incompatible with Hung's Oxygen-Free Gas

Claim 1 is directed to a method of *etching a dielectric layer with selectivity to an underlying stop layer*, comprising . . . (c) etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a *hydrogen-free* fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an *oxygen-containing* gas and optional carrier gas.

The Official Action cited Wang for disclosing the use of oxygen gas with the main-etchant gas. In particular, the Official Action cites a portion of Wang stating that "[t]he above processes can be modified by the addition of carbon monoxide, nitrogen, or oxygen, all of which are known to enhance selectivity and increase the etch stop margin" (column 10, lines 23-26). As pointed out above, Hung teaches away from using oxygen as part of the over etch gas. The Official Action fails to explain why one of ordinary skill in the art would have been led to go directly against the teachings of Hung, i.e., Hung's teaching that "oxygen destroys any nitride selectivity" (column 10, line 51 of Hung).

F. Lack of Motivation and No Reasonable Expectation of Success

As discussed above, the Official Action has not set forth a tenable basis establishing the requisite motivation to combine Wang with Hung in a manner that would produce the claimed method. Furthermore, the Official Action does not set forth an explanation as to why one of ordinary skill in the art would have had a reasonable expectation of success in combining Hung and Wang as suggested in the Official Action. Given Hung's teaching to use a hydrogen-containing oxygen-free gas for the over etch and an oxygen-containing gas for removing the nitride layer, it is submitted that the Official Action fails to establish a reasonable expectation of success in modifying Hung to include the oxygen-containing gas of Wang. Thus, it is submitted that a person of ordinary skill in the art would not have been led to use a hydrogen-free, oxygen-containing over etch gas to etch openings in the dielectric layer of Hung.

In view of the foregoing, Applicants respectfully submit that Claim 1 and all the claims dependent therefrom are clearly patentable over the combination of Hung and Wang.

XI. Argument III

A. Examiner's Rationale for the Rejection

Claims 6-8 and 13 stand rejected under 35 U.S.C. §103(a) as allegedly being unpatentable over Hung and Wang in further view of U.S. Patent No. 6,228,438 to Schmitt ("Schmitt"). The reasons for the rejection are set forth in numbered paragraph 4, on pages 7-8 of the Official Action. The Official Action alleges that (1) Schmitt discloses a dual

frequency capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode (see column 8, lines 1-10) and (2) that it would have been obvious to modify the etch process of Hung and Wang to include other commercially available plasma etch reactors. As to Claims 7 and 8, the Official Action acknowledges that "[t]he combined prior art does not disclose the flow rate of oxygen (O_2) for the process" but alleges oxygen is a result effective process variable. This rejection should be reversed for the following reasons.

B. Claimed Subject Matter

Claim 6 depends from Claim 1 and further sets forth that the plasma etch reactor comprises a dual frequency capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode, RF energy being supplied at two different frequencies to either the bottom electrode or at different first and second frequencies to the showerhead electrode and bottom electrode.

Claim 7 depends from Claim 1 and further sets forth that the etchant gas is nitrogen-free, the C_xF_y gas is at least C_4F_6, the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 2 to 50 sccm C_4F_6, 2 to 50 sccm O_2 and 50 to 800 sccm Ar.

Claim 8 depends from Claim 1 and further sets forth that the C_xF_y gas is at least C_4F_6, the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 10 to 25 sccm C_4F_6, 5 to 20 sccm O_2 and 50 to 300 sccm Ar.

Claim 13 depends from Claim 1 and further sets forth that the plasma etch reactor is a capacitively coupled plasma reactor having a powered showerhead electrode and/or a powered bottom electrode, the showerhead electrode being supplied 0 to 3000 watts of RF energy and the bottom electrode being supplied 0 to 3000 watts of RF energy.

C. The Etch Reactor of Schmitt is Unsuitable for Hung's Process

Regarding Claims 6 and 13, Hung relates to a process wherein a high-density plasma etch reactor is used (column 7, lines 33-48 and column 11, lines 1-10). Schmitt

relates to a capacitively coupled RF plasma reactor which does not provide a high density plasma. Accordingly, because the plasma reactor of Schmitt would be unsuitable for Hung's high-density plasma etch process, it would not have been obvious to a person of ordinary skill in the art to modify Hung as suggested in the Official Action. As to Claims 6 and 8, the Official Action does not address Hung's teaching away from use of oxygen. As such, the Official Action does not establish that oxygen is a result effective variable in Hung's process. Moreover, Claims 6-8 and 13 depend from Claim 1 and thus are patentable over the cited references for at least the reasons set forth above.

XII. Conclusion

In view of the foregoing, Appellants respectfully submit that the claimed invention would not have been obvious to one having ordinary skill in the art at the time of the invention. Accordingly, reversal of each of the rejections is respectfully requested.

Respectfully submitted,

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APPENDIX A

The Appealed Claims

1. A method of etching a dielectric layer with selectivity to an underlying stop layer, comprising:

supporting a semiconductor substrate in a plasma etch reactor, the substrate including a dielectric layer over a stop layer;

supplying an etchant gas to the plasma etch chamber; and

etching openings in the dielectric layer by energizing the etchant gas into a plasma state, the etchant gas comprising a hydrogen-free fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an oxygen-containing gas and optional carrier gas.

2. The method of Claim 1, wherein the openings comprise vias, contacts, and/or trenches of a dual damascene structure, a self-aligned contact structure or self-aligned trench structure.

3. The method of Claim 1, wherein the stop layer is silicon nitride and the etch rate selectivity of the dielectric to the silicon nitride is at least 10.

4. The method of Claim 1, wherein the dielectric layer comprises doped or undoped silicon oxide layer or low-k material and the stop layer comprises a silicon nitride layer.

5. The method of Claim 1, wherein the plasma etch reactor comprises an ECR plasma reactor, an inductively coupled plasma reactor, a capacitively coupled plasma reactor, a helicon plasma reactor or a magnetron plasma reactor.

6. The method of Claim 1, wherein the plasma etch reactor comprises a dual frequency capacitively coupled plasma reactor including an upper showerhead electrode and a bottom electrode, RF energy being supplied at two different frequencies to either the bottom electrode or at different first and second frequencies to the showerhead electrode and bottom electrode.

7. The method of Claim 1, wherein the etchant gas is nitrogen-free, the C_xF_y gas is at least C_4F_6, the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 2 to 50 sccm C_4F_6, 2 to 50 sccm O_2 and 50 to 800 sccm Ar.

8. The method of Claim 1, wherein the C_xF_y gas is at least C_4F_6, the oxygen containing gas is at least O_2 and the carrier gas is Ar, the etchant gas being supplied to the plasma etch reactor through a showerhead electrode at flow rates of 10 to 25 sccm C_4F_6, 5 to 20 sccm O_2 and 50 to 300 sccm Ar.

9. The method of Claim 1, wherein a ratio of flow rates of the C_xF_y to oxygen containing reactant is 0.5:1 to 5:1.

10. The method of Claim 1, wherein a ratio of flow rates of the C_xF_y to oxygen containing reactant is 1:1 to 2:1.

11. The method of Claim 1, wherein pressure in the plasma etch reactor is 10 to 200 mTorr and/or temperature of the substrate support is -20°C to +80°C.

12. The method of Claim 1, wherein pressure in the plasma etch reactor is 50 to 100 mTorr and/or temperature of the substrate support is +20°C to +60°C.

13. The method of Claim 1, wherein the plasma etch reactor is a capacitively coupled plasma reactor having a powered showerhead electrode and/or a powered bottom electrode, the showerhead electrode being supplied 0 to 3000 watts of RF energy and the bottom electrode being supplied 0 to 3000 watts of RF energy.

14. The method of Claim 1, wherein the etchant gas includes CO supplied to the plasma etch reactor at a rate of 50 to 500 sccm CO.

15. The method of Claim 1, wherein the C_xF_y is either C_4F_6 or C_6F_6.

16. The method of Claim 1, wherein the C_xF_y is C_4F_6 and the oxygen containing gas is O_2, the C_4F_6 and O_2 being supplied to the plasma etch reactor at flow rates having a ratio of C_4F_6:O_2 of 0.5:1 to 5:1.

17. The method of Claim 1, wherein the C_xF_y is C_4F_6 and the oxygen containing gas is O_2, the C_4F_6 and O_2 being supplied to the plasma etch reactor at flow rates having a ratio of C_4F_6:O_2 of 1:1 to 2:1.

18. The method of Claim 1, wherein the C_xF_y is C_4F_6 and the oxygen containing gas is supplied to the plasma etch chamber in an amount sufficient to avoid etch stop during etching of the openings.

19. The method of Claim 1, wherein the etched openings open onto flat and corner portions of the stop layer, the dielectric layer comprises BPSG and the stop layer comprises silicon nitride, the etch rate selectivity of the BPSG to the flat and corner portions of the silicon nitride being at least 15.

20. The method of Claim 1, wherein the dielectric layer comprises BPSG and the stop layer comprises silicon nitride, the C_xF_y gas being C_4F_6 and the oxygen containing gas being O_2, the C_4F_6 and O_2 being supplied to the plasma etch reactor at flow rates having a ratio of O_2:C_4F_6 of 0.5 to 1.2.

21. The method of Claim 1, wherein the etch rate selectivity of the dielectric to the stop layer is greater than 30:1.

22. The method of Claim 1, wherein the etching of the dielectric layer is carried out in a single step.

23. The method of Claim 1, wherein the etchant gas is hydrogen-free.

24. The method of Claim 1, wherein the etchant gas consists essentially of a hydrogen-free fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an oxygen-containing gas and optional carrier gas.

25. The method of Claim 1, wherein the etchant gas consists of a hydrogen-free fluorocarbon gas represented by C_xF_y gas wherein $y/x \leq 1.5$, an oxygen-containing gas and optional carrier gas.